El-Shorouk Academy	The Higher Institute of Engineering
Department of Electronics and Communications	
Third year Communications	Systems and Networks

Sheet five
Active RC Realization of Network

[1] Find two Active RC Realization of the passive filter shown in figure (1) compare the number of elements

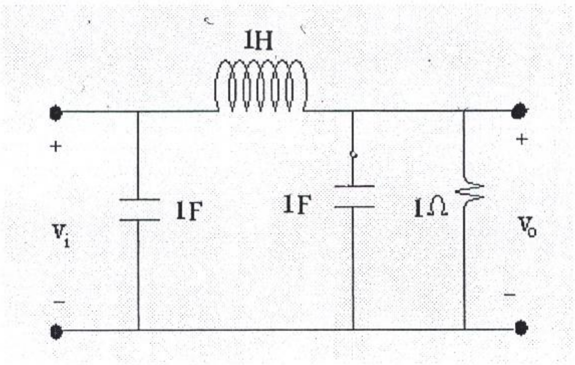

Figure (1)

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[2] Find two Active RC Realization of the third order passive low pass filter (LPF) shown in figure (2)

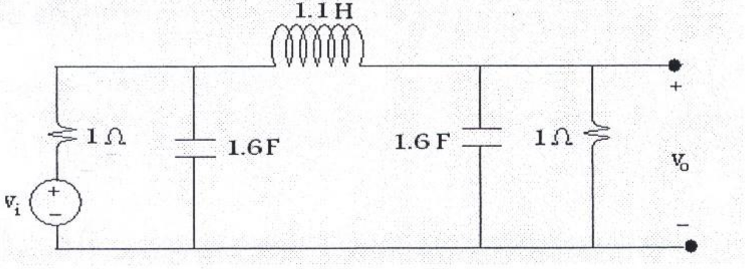

Figure (2)

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[3] Find two Active RC Realization of the passive low pass filter (LPF) shown in figure (3)

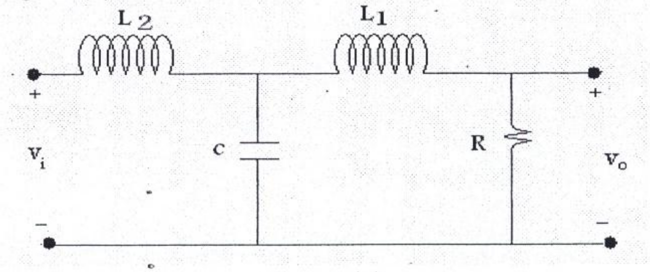

Figure (3)

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[4] Find two Active RC Realization of the passive high pass filter (HPF) shown in figure (4)

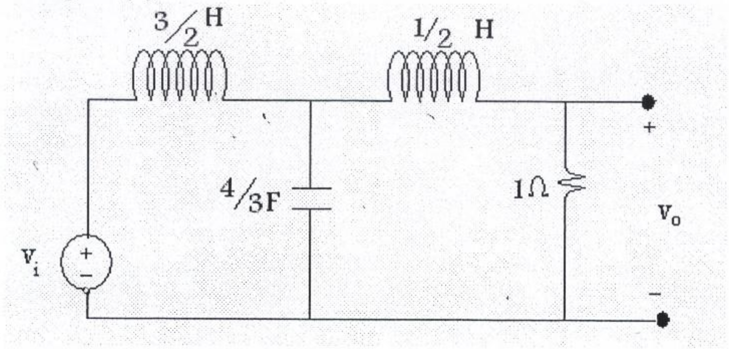

Figure (4)

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[5] Synthesis the following transfer function using active RC circuits with no more than one op amp

(i) $F_1(S)=\frac{5S+3}{S+2}$ (ii) $F_2(S)=\frac{3S+8}{S+8}$

(iii) $F_3(S)=-\frac{2}{S+4}$ (iv) $F_4(S)=\frac{-3S+2}{S+4}$

(v) $F_5(S)=\frac{2S+4}{S+4}$ **(vi)** $F_6(S)=\frac{-8}{S+4}$

(vii) $F_7(S)=\frac{-3S}{S+4}$ **(viii)** $F_8(S)=\frac{S+8}{S+4}$

1/SC

……………………………………………………………………………………

[6] A first order all pass section characterized by

$T(S)=K_1\frac{S-a}{S+a}$ can be realized using the circuit shown in figure (5) develop the design equations.

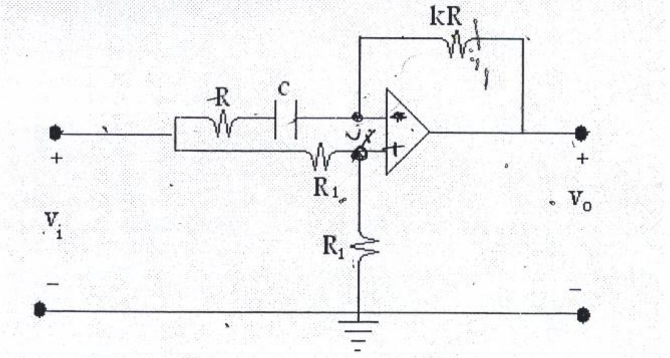

Figure (5)

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[7] Consider the circuit shown in figures (6a and 6b) represent two more first order all pass networks

(i) Find k to make $\frac{V_O}{V_i}$ all pass.

(ii) Sketch the phase versus ω for each of the two circuits

(iii) Design a circuit to provide a phase shift of 135 at a radian frequency of 100 radian/ seconds (use c=0.1 μF)

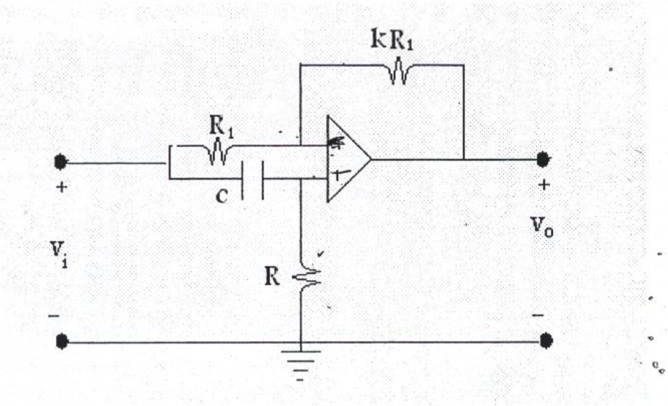

Figure (6a)

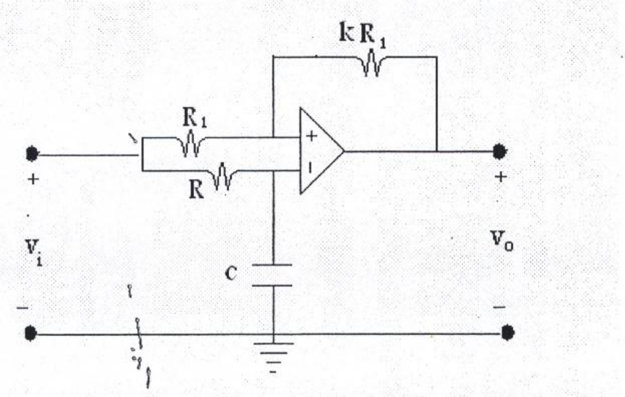

Figure (6b)

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[8](i)Derive an expression for the transfer function of the circuit shown in figure (7)

(ii) Find the value of R to get a phase shift of 120° at f=50 Hz, capacitor C=1 μF.

(iii) What is the kind of filter realized?

(iv) Show how it can be used to get a set of 3 phase 60Hz voltages separated by 120o and equal in magnitude use capacitor C=1 μF.

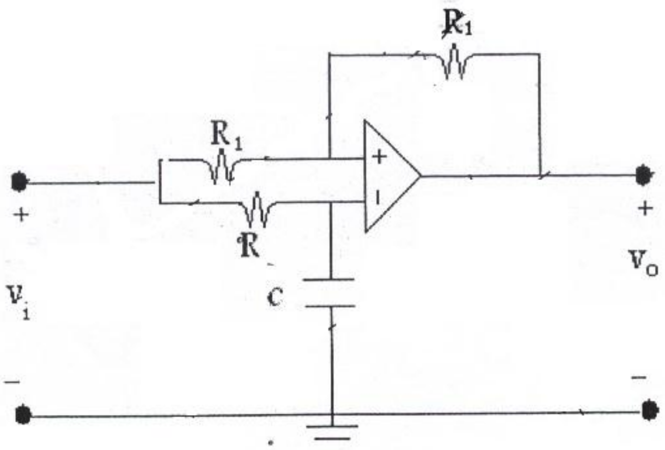

Figure (7)

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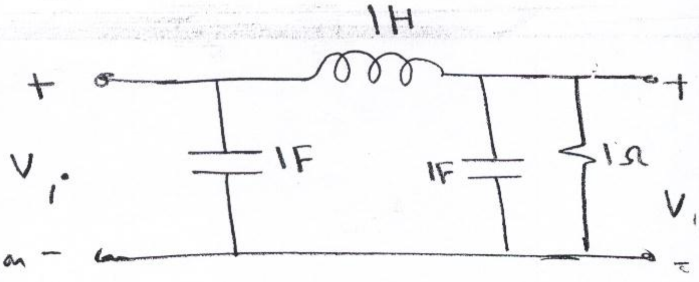
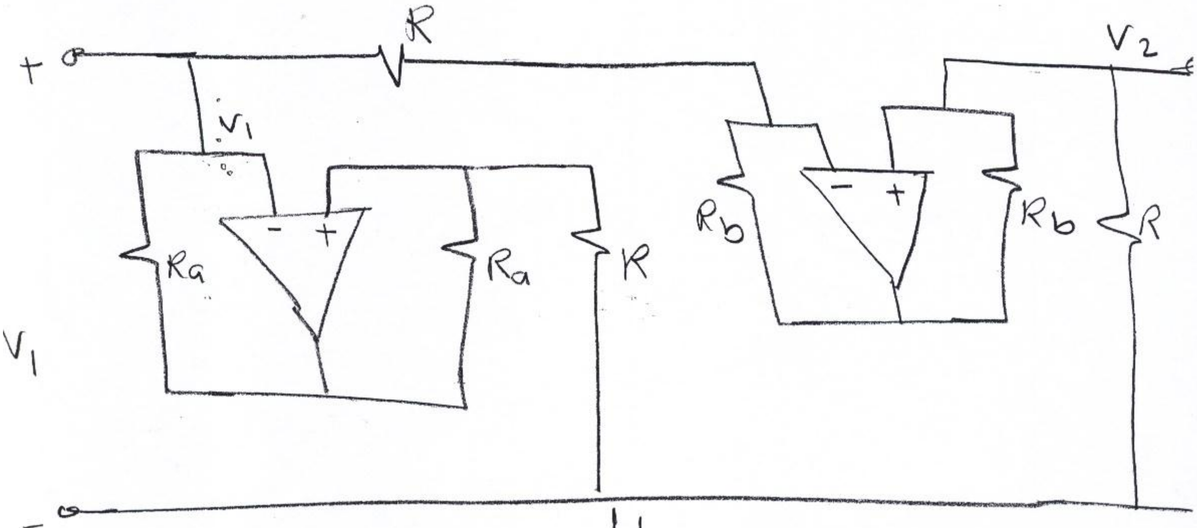
Sheet ⑤

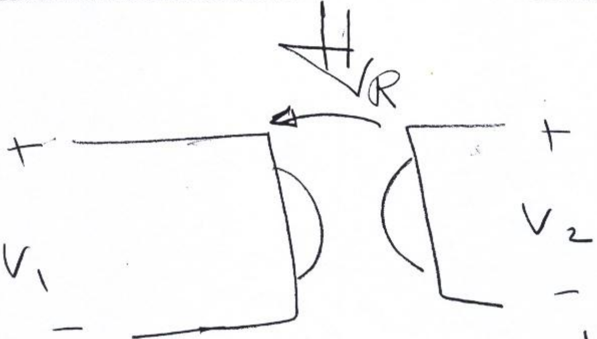
I- RC - Realization

- using gyrator
- using Bruton transformation

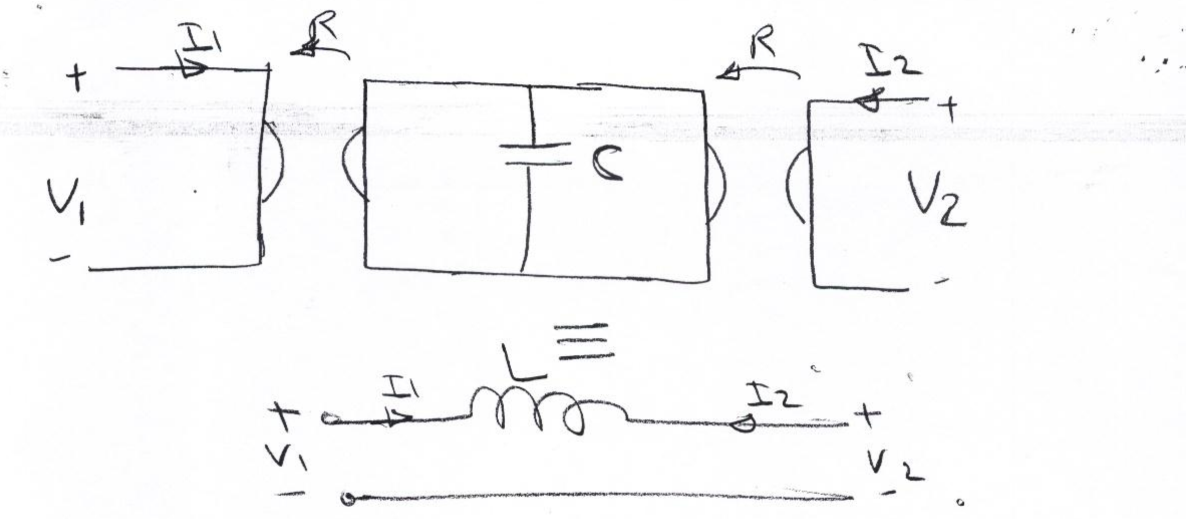


II- using Debo Gyrator





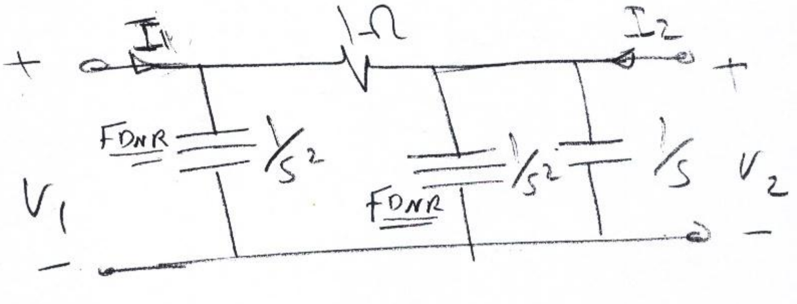
* to Realize Floating Inductor we used Two Gyrator + 1-Capacitor



∴ All Circuit = (22) element

= (4) op-amp + (15) Resistor + (3) Capa

[2]- using Bruton transformation



All Circuit = (2) FDNR + (1) Resistor + (1) Capacit

= (16) element

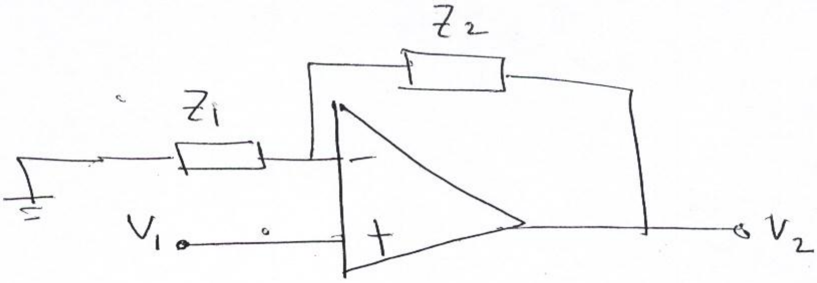
FDNR = (7) element = (2) op-amp + (3) resitor

+ (2) Capacitor

* We use Bruton (16) < Gyrator (22)

[5]- Synthesis the following transfer function [1]:

[1]- $F(s) = \dfrac{5s+3}{s+2}$

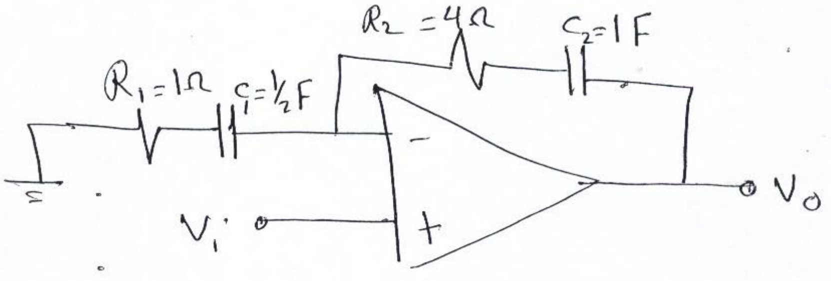


$$F(s) = \frac{V_o}{V_1} = 1 + \frac{Z_2}{Z_1}$$

$$\therefore \frac{Z_2}{Z_1} = \frac{5s+3}{s+2} - 1 = \frac{5s+3-s-2}{s+2}$$

$$\frac{Z_2}{Z_1} = \frac{4s+1}{s+2} = \frac{4+1/s}{1+2/s}$$

$$\therefore Z_2 = 4 + 1/s \quad , \quad Z_1 = 1 + 2/s$$



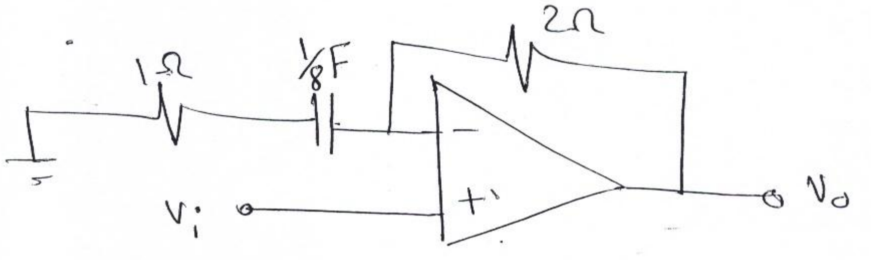
(ii) $F_2(s) = \frac{3s+8}{s+8} = 1 + \frac{Z_2}{Z_1}$

$$\frac{Z_2}{Z_1} = \frac{3s\cancel{+8}-s\cancel{-8}}{s+8} = \frac{2s}{s+8} = \frac{2}{1+8/s}$$

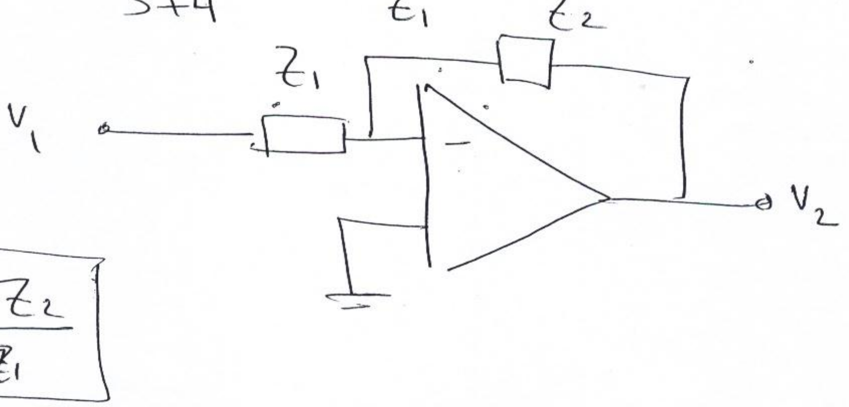
∴ ~~$Z_2 = 2s$~~

$$\frac{Z_2}{Z_1} = \frac{2}{1+8/s}$$

$Z_1 = 1 + 8/s\ \Omega$, $Z_2 = 2\ \Omega$



(iii) $F_3(s) = -\frac{2}{s+4} = \frac{-Z_2}{Z_1}$



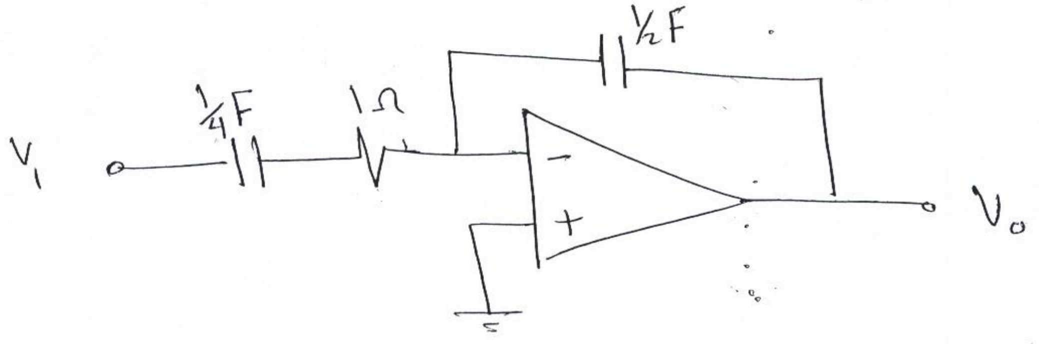
$$\boxed{\frac{V_2}{V_1} = -\frac{Z_2}{Z_1}}$$

$\boxed{3}$

$$\therefore \frac{-2}{s+4} = -\frac{Z_2}{Z_1}$$

$$\frac{2/s}{1+4/s} = \frac{Z_2}{Z_1}$$

$$\therefore \; Z_2 = 2/s \quad , \quad Z_1 = 1 + \frac{1}{\frac{1}{4}s}$$

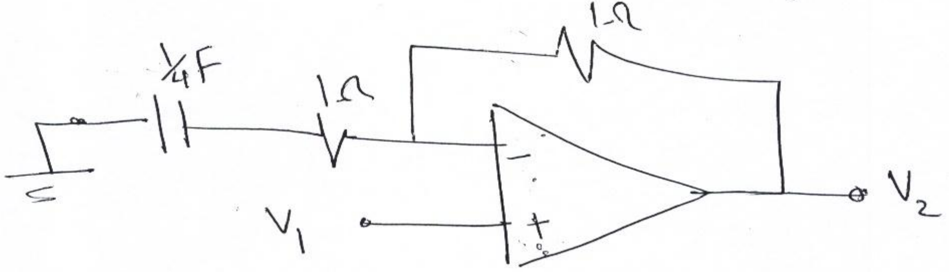


$$* \; F_4(s) = \frac{-3s+2}{s+4}$$

* $F_5(s) = \frac{2s+4}{s+4} = 1 + \frac{Z_2}{Z_1}$

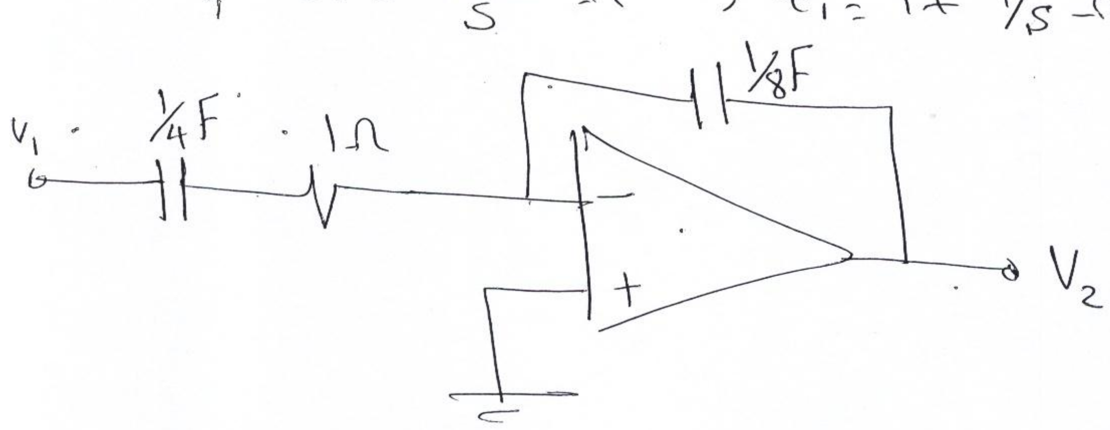
$$\frac{Z_2}{Z_1} = \frac{2s+4-s-4}{s+4} = \frac{s}{s+4} = \frac{1}{1+\frac{1}{\frac{1}{4}s}}$$

$\therefore \quad Z_2 = 1\,\Omega \quad , \quad Z_1 = 1 + \frac{1}{s\frac{1}{4}}$



$F_6(s) = \frac{-8}{s+4} = \frac{-Z_2}{Z_1} = \frac{-8/s}{4/s+1}$

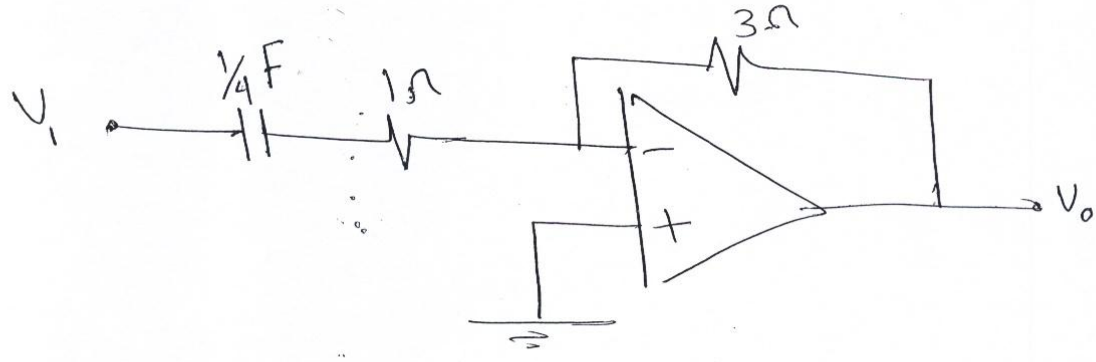
$\therefore \quad Z_2 = \frac{8}{s}\,\Omega \quad , \quad Z_1 = 1 + 4/s\ \Omega$



* $F_7(s) = \frac{-3s}{s+4} = \frac{-Z_2}{Z_1}$

$\therefore \frac{Z_2}{Z_1} = \frac{3s}{s+4} = \frac{3}{1+4/s}$

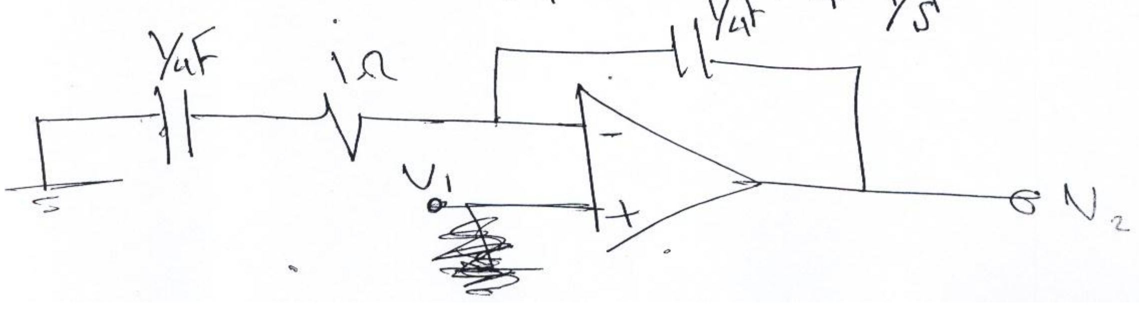
$\therefore Z_2 = 3\,\Omega \quad , \quad Z_1 = 1 + \frac{4}{s}\,\Omega$



* $F_8(s) = \frac{s+8}{s+4} =$

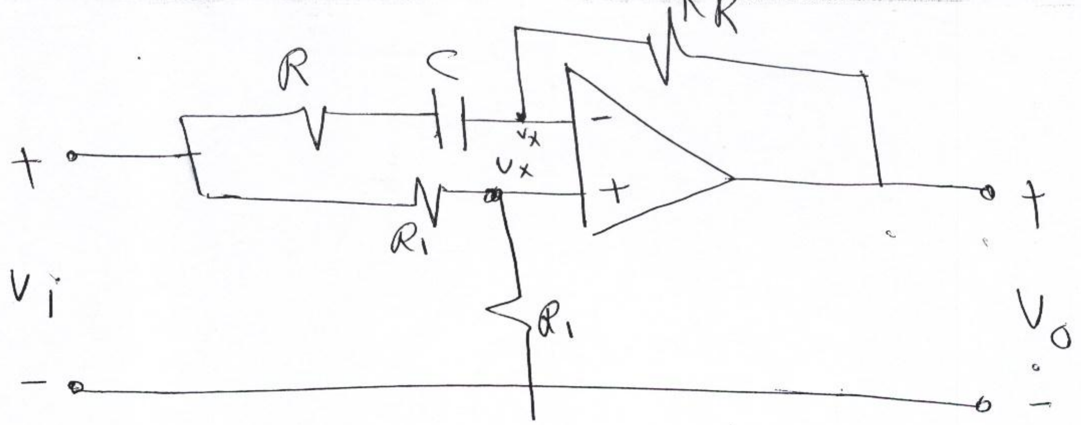
$1 + \frac{Z_2}{Z_1} = \frac{s+8}{s+4} \Rightarrow \frac{Z_2}{Z_1} = \frac{s+8-s-4}{s+4}$

$\therefore \frac{Z_2}{Z_1} = \frac{4}{s+4} = \frac{4/s}{1+4/s}$



$\boxed{6}$

$\boxed{6}$- $T(s) = K_1 \dfrac{S-a}{S+a}$



$$U_x = \frac{R_1}{R_1+R_1} V_i \Rightarrow \boxed{V_x = \frac{V_i}{2}}$$

$$\frac{U_x - U_o}{KR} = \frac{U_i - U_x}{R + \frac{1}{SC}}$$

$$\therefore U_x\left(\frac{1}{KR} + \frac{1}{R+\frac{1}{SC}}\right) = \frac{V_o}{KR} + \frac{U_i}{R+\frac{1}{SC}}$$

$$\frac{U_i}{2}\left(\frac{KR+R+\frac{1}{SC}}{\cancel{KR(R+\frac{1}{SC})}}\right) = \frac{U_o(R+\frac{1}{SC})+V_i KR}{\cancel{KR(R+\frac{1}{SC})}}$$

$$\therefore V_i\left[KR+R+\frac{1}{SC} - 2KR\right] = V_o\left(R+\frac{1}{SC}\right)$$

$$\frac{U_o}{U_i} = \frac{R(1-K)+\frac{1}{SC}}{R+\frac{1}{SC}} = \frac{SCR(1-K)+1}{SCR+1}$$

$a=-1$ $\quad$ **CR=1** $\quad$ c $\quad$ $K_1=1$, $K=0$

$\boxed{7}$- Find $\boxed{7}$:

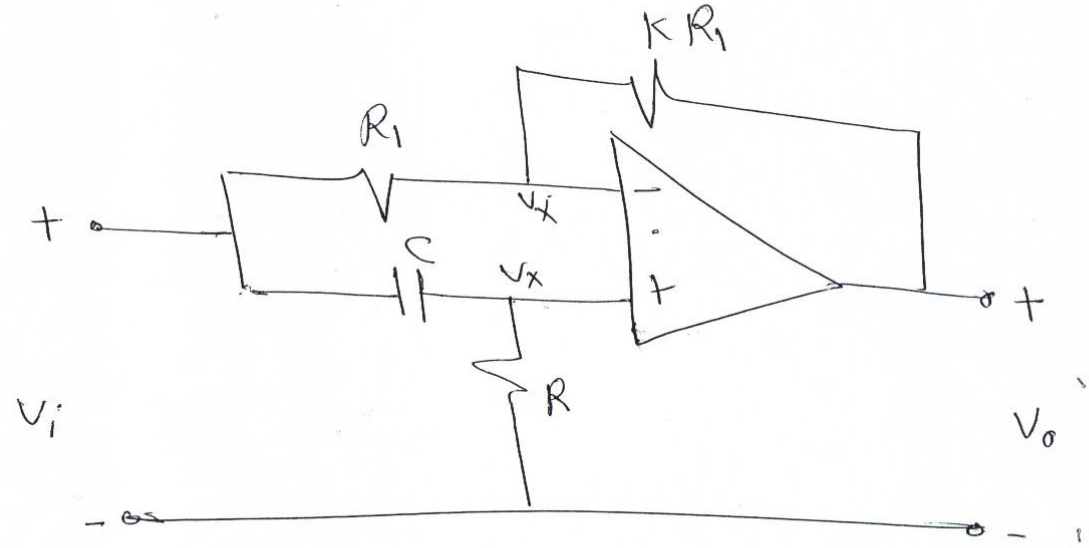
a) K to make $\frac{V_o}{V_i}$ all pass filter

b) Sketch $\theta(\omega)$ versus ω

c) Design a circuit to provide phase shift = 135°

at $\omega = 100$ rad/sec . S $C = 0.1\,\mu f$

$\boxed{7}$- For H.P.F



$$V_x = V_i \frac{R}{R + \frac{1}{sC}} = V_i \frac{SCR}{SCR+1} \longrightarrow ①$$

$$\frac{V_i - V_x}{\cancel{R_1}} = \frac{V_x - V_o}{K\cancel{R_1}}$$

$$\therefore V_x(1+k) - kV_i = V_o \Rightarrow V_i \frac{SCR(1+k)}{SCR+1} - kV_i =$$

$$\therefore \frac{V_o}{V_i} = \frac{SCR - K}{SCR + 1}$$

* to make $\frac{V_o}{V_i}$ all pass filter "K" must be equal = 1

$$\boxed{K = 1}$$

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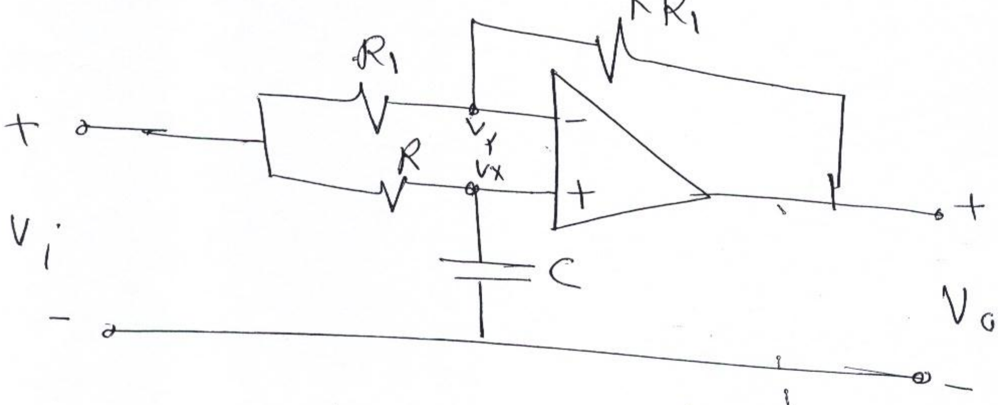
[2]- For L.P.F



$$V_x = V_i \frac{1/sc}{R + 1/sc} = V_i \frac{1}{scR + 1}$$

$$\frac{V_i - V_x}{\cancel{R_1}} = \frac{V_x - V_o}{K\cancel{R_1}}$$

$$V_x(1+k) - KV_i = V_o$$

$$V_i\left[\frac{(1+k)}{SCR+1} - K\right] = V_o \Rightarrow V_i\left[\frac{1 + \cancel{K} - KSCR - \cancel{K}}{SCR + 1}\right] = V_o$$

[9]-

$$\therefore \frac{V_o}{V_i} = \frac{1 - kSCR}{1 + SCR}$$

* To make $\frac{V_o}{V_i}$ all pass filter $\boxed{K = 1}$

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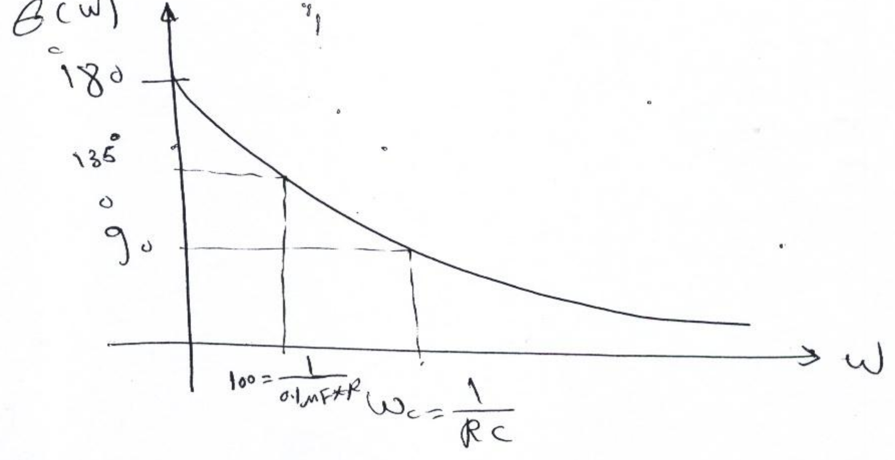
[b]- Sketch "$\theta(w)$" with "w".

i) For H.P.F

$$H(s) = \frac{V_o}{V_i} = \frac{SCR - 1}{SCR + 1} \Rightarrow H(w) = \frac{jwRC - 1}{jwRC + 1}$$

$$|H(w)| = \sqrt{\frac{(wRC)^2 + 1}{(wRC)^2 + 1}} = 1$$

$$\boxed{\theta(w) = 180 - 2 \tan^{-1} wRC}$$

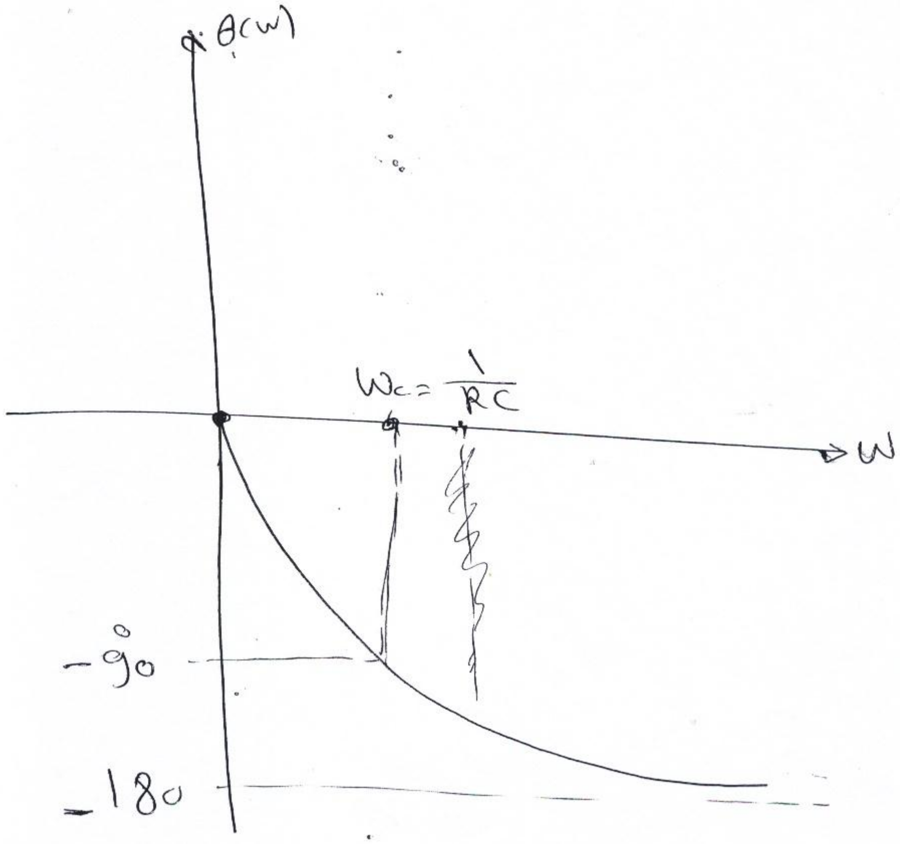


For L.P.F

$$H(s) = \frac{V_o}{V_i} = \frac{1 - sCR}{1 + sCR} \Rightarrow$$

$$H(w) = \frac{1 - jwRC}{1 + jwRC} = |H(w)| \angle -2\tan^{-1} wRC$$

$$\therefore \theta(w) = -2\tan^{-1} wRC$$



• [3] - Design a Circuit provide phase shift = 135°. - [4].

$\omega = 100$ rad/sec $C = 0.1\,\mu F$

& by using H.P.F circuit

$$\theta(\omega) = 180 - 2\tan^{-1}\omega RC$$

$$135 = 180 - 2\tan^{-1} 100 * R * 10^{-7}$$

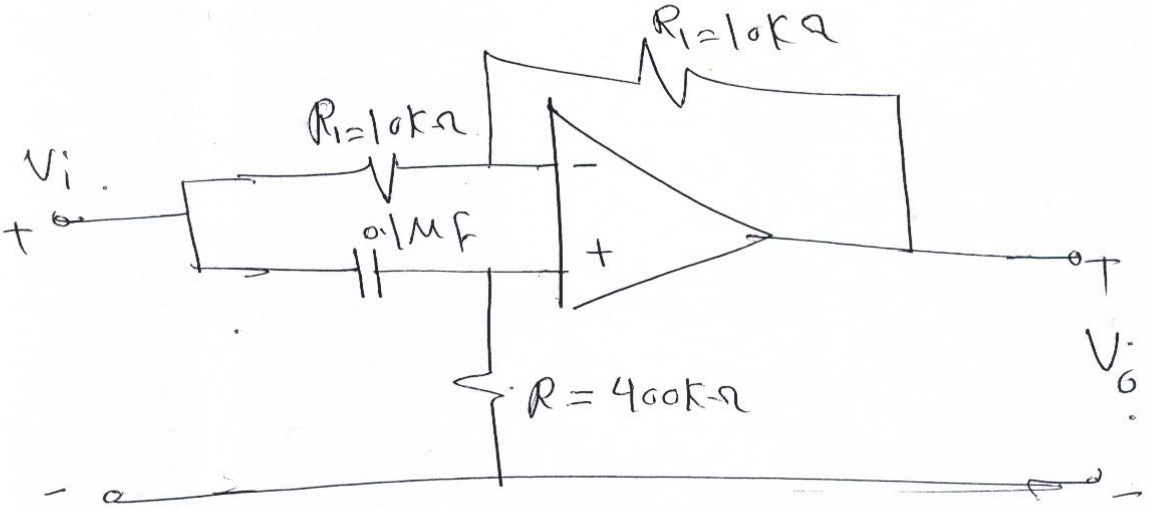
$$\therefore 100 * R * 10^{-7} = \tan(22.5)^{\circ}$$

$$R = \frac{0.41}{10^{-5}} \simeq 400\,K\Omega$$

$$\boxed{R = 400\,K\Omega}$$

$R_1 = 10\,K\Omega \Rightarrow$ assume

~~R_2~~



* الـــع لارقم في نفـــس اتكلم

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